FIELD TEST DRAFT

JUNIOR HIGH SCIENCE

PROGRAM OF STUDIES

with excerpts from draft curriculum guide

Draft May 4, 1988

A. PROGRAM RATIONALE AND PHILOSOPHY

"The aim of education is to develop the knowledge, the skills and the positive attitudes of individuals, so that they will be self-confident, capable and committed to setting goals, making informed choices and acting in ways that will improve their own lives and the life of their community."

Secondary Education in Alberta, 1985

Science education contributes to this overall aim of education in several ways:

- first, by providing learning experiences that help students understand and interpret the world in which they live
- second, by developing knowledge, skills and attitudes that support the intelligent and responsible application of science and technology, and
- third, by developing a foundation of knowledge, skills and attitudes that support further study of the sciences.

To achieve these purposes, the Junior High Science Program provides a broad range of learning experiences in the biological and physical sciences. In articulation with the elementary and senior high programs, the junior high program provides opportunity for study of most of the major branches of science, building on the experiences of the elementary school and providing a foundation for more formal studies at the senior high level.

In keeping with the developmental level of students, concepts are introduced by reference to a broad range of experiences, including those provided by first-hand investigation. These learnings are extended as students are given opportunities to reflect on their experiences, learning to discover and construct meaning through careful and focused thought. Learning activities are thus designed not only to illustrate established science ideas, but also to allow students to construct new meanings and find new applications to what they learn.

Learnings within the program are presented in contexts that illustrate the development and application of science. As in the previous program, frequent attention is given to the processes by which scientific knowledge is gathered, largely by involving students directly in the practise of scientific inquiry. In the revised program, significant attention is also given to other contexts of science: in particular the application of science to the solution of practical problems, and the examination of the implications of science and technology with respect to personal and social impact. The processes of problem solving and decision making are given direct attention in learning activities: students are thus involved in ways that will stimulate their critical and creative skills.

B. PROGRAM GOALS

SCIENTIFIC LITERACY

In broad terms, the intended outcome of the secondary science program is the development of a scientifically literate citizenry. A scientifically literate person is one who:

- demonstrates a working knowledge and practical understanding of the sciences
- has the ability to evaluate scientific evidence
- understands the processes by which scientific knowledge is developed and can adapt those processes for personal use
- applies science concepts, theories and processes to the investigation of everyday problems
- understands the relationship of science and technology
- demonstrates awareness of how science and technology can function responsibly in a social context
- recognizes the limitations as well as the usefulness of science and technology in advancing human welfare, and
- demonstrates a continuing interest in science and technology.

GOALS OF THE JUNIOR HIGH SCIENCE PROGRAM

The goals for the Junior High Science Program are:

1. Development of foundation knowledge of the sciences

2. Development of an understanding of the nature of science, and acquisition of science inquiry skills

3. Development of foundation knowledge of technologies, and acquisition of skills in technological problem solving

4. Development of awareness of the impacts of science on society and environments, and the application of decision-making skills to science related problems

5. Development of lifelong interest, intellectual curiosity and appreciation of science.

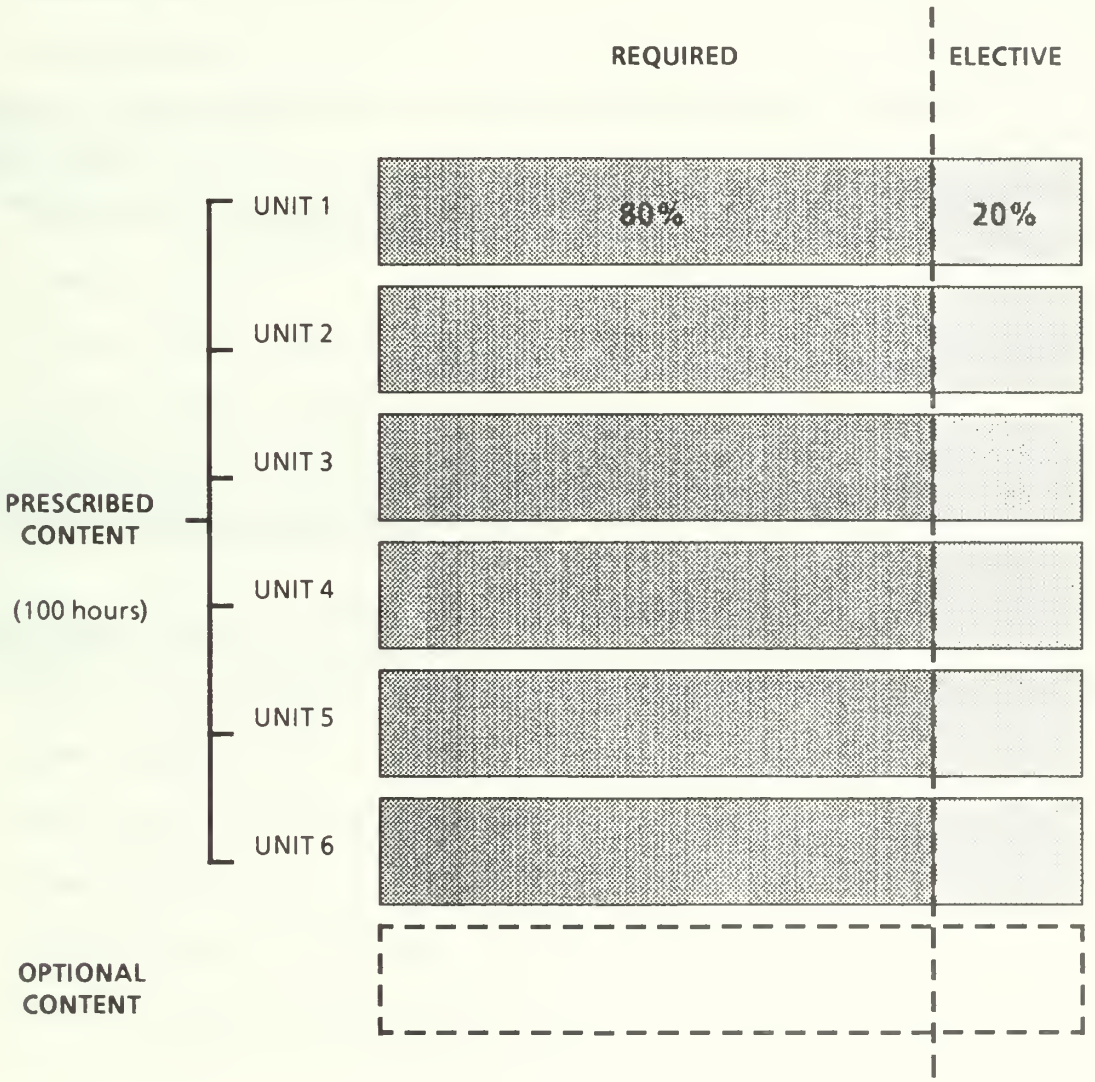
C. CONTENT

PROGRAM FRAMEWORK

TOPICS OF STUDY

The program is comprised of six units at each grade level. Each unit focuses on a particular science topic, and develops a learning context that contributes to the students' overall understanding of science and technology.

The instructional time for each unit varies, but at each level the program is based on 100 hours of instructional time.



REQUIRED / ELECTIVE COMPONENTS

Each unit of the program has a required component and an elective component, defined as follows:

The required component encompasses the knowledge, skills and attitudes that all students should be expected to acquire. This component comprises 80% of the program.

The elective component, which comprises 20% of the program, provides opportunities to adapt and enhance instruction to meet the diverse needs, abilities and interest of individual students. It encourages enrichment and remediation consistent with the content and objectives of the required component.

The program content for both the required component and the elctive component is defined by the same statements of objectives.

OPTIONAL CONTENT

(Note: there will be no requirement that optional content be included within a school's Junior High Science Program.)

Instructional content that is provided beyond the mandatory 100 hours of instruction shall be deemed to be optional. Optional content to the program may take several forms:

1. an extension of a prescribed unit
2. a suggested option identified in the program of studies
3. an option based on local choice.

Selection of topics for development as optional units may be made at the local school level based on local needs and resources. To assist the school in the choice and development of topics, outlines will be provided and resources will be identified for several "suggested options" at each level. Optional topics may also include units which have been developed or selected locally, subject to the following provisions being met.

1. All program content must support the overall goals of the program.
2. Inclusion of optional content must not detract from the achievement of required program objectives or from elective content associated with the required program.

PRESCRIBED SCOPE AND SEQUENCE

Grade Seven Program

1. Characteristics of Living Things
2. Structures and Design
3. Force and Motion
4. Temperature and Heat Measurement
5. Micro-organisms and Food Supplies
6. Evidence of Erosion

Grade Eight Program

1. Solutions and Substances
2. Energy and Machines
3. Consumer Product Testing
4. Changes in the Earth's Crust
5. Growing Plants
6. Interactions and Environments

Grade Nine Program

1. Diversity of Living Things
2. Electromagnetic Systems
3. Heat Energy: Transfer and Conservation
4. Fluids and Pressure
5. Chemical Properties and Changes
6. Environmental Quality: A Case Study

PRESCRIBED SCOPE AND SEQUENCE

Grade Seven Program

1. Characteristics of Living Things

Concepts
- general characteristics of living things
- variation among living things
- growth patterns
- structural adaptations
- stimulus and response
- behavioural adaptations

Skills
- science inquiry skills, with particular emphasis on:
  - observation of living things
  - experimental design; designing a simple experiment to determine the responsiveness of a particular organism to given stimuli
  - monitoring and measuring skills
    - determining lung capacity
    - determining respiration and heart rates
    - determining responsiveness to stimuli
  - inferences based on observations of living things
- skills in caring for living things

Attitudes
- appreciation of the beauty and complexity of living things
- commitment to the care of living things
- appreciation of the adaptive value of structural and behavioural characteristics of plants and animals
- confidence in personal ability to design and conduct a scientific investigation of living plants or animals
- awareness of techniques for monitoring life functions

2. Structures and Design

Concepts
- design in the natural world
- design in the built environment and in manufactured things
- functions of different parts of plants and animals; e.g., support, containment
- functions of built objects; e.g., shelter, containment, support
- strength of materials
- tension and compression (qualitative treatment)
- design as a factor in strength of structures
- design of plant and animal support systems; e.g., stems and skeletons
- beams, columns and cantilevers
- design of bridges and buildings
- hinged systems (in constructions and in living things)
- choice of materials to suit a function
- construction in space

Skills

- technological problem-solving skills:
  - designing to serve a given function
  - proposing alternative design solutions to a given problem
  - evaluating a design
- manipulative skills and techniques:
  - improvising construction of load bearing structures using materials such as cardboard or paper
  - testing a load bearing structure

Attitudes

- appreciation of functional value of good design
- appreciation of aesthetic value of good design
- awareness and appreciation of variation in design as providing multiple alternative solutions to given problems
- appreciation of the presence of similar principles of design in both natural and manufactured things
- confidence in personal ability to design and build a functional construction

3. Force and Motion

Concepts

- force
- kinds of forces; e.g., mechanical, gravitational, magnetic, frictional, buoyant, electrostatic
- measurement of forces
- gravity as a force
- mass
- relationship of mass and weight
- friction
- factors that affect friction
- motion in space
- action / reaction
- inertia

Skills

- science inquiry skills:
  - estimating forces and masses
  - measuring forces and masses
  - predicting consequences of forces
  - selecting and/or developing appropriate techniques for measuring forces and masses
- technological problem-solving skills:
  - generating ideas about appropriate ways to reduce friction in a variety of practical situations
- manipulative skills and techniques:
  - constructing improvised force measurers and balances
  - constructing model friction reduction systems

Attitudes

- awareness of the need for specialized terminology to distinguish between force and mass
- appreciation of current technologies used in measuring force and mass
- awareness of the pervasiveness of frictional forces in natural and human-made systems
- awareness of the desirable and undesirable aspects of frictional forces
- appreciation of technologies used to alleviate friction

4. Temperature and Heat Measurement

Concepts

- temperature
- accuracy in temperature measurement
- calibration
- units of temperature
- liquid thermometers
- air thermometers
- specialized thermometers; e.g., thermocouples, bimetallic strips
- heat
- units of heat energy: the Joule
- heat generation from different sources
- energy content of fuels

Skills

- science inquiry skills:
  - temperature estimation skills
  - temperature measurement skills
- technological problem-solving skills:
  - designing and building temperature measuring devices using improvised materials
  - evaluating the appropriateness of alternative designs (of thermometers) for a particular application

Attitudes

- respect for precision in measurement
- appreciation of human ingenuity and skill in the development of technologies used in measurement (focus on temperature measurement)
- recognition of the need for specialized instrumentation for specific applications

5. Micro-organisms and Food Supplies

Concepts

- micro-organisms: single celled and multiple celled organisms
- habitats for micro-organisms
- roles of micro-organisms in natural systems:
  - food producers
  - consumers
  - decomposers
  - parasites and diseases
- role of micro-organisms in food production
- role of micro-organisms in food spoilage

- technologies for preparing, preserving and protecting human food
- health problems that result from food preparation and handling procedures
- safety standards for preparing and handling of food
- issues regarding the setting of appropriate safety standards
- problems in regulating and enforcing safety standards

Skills
- scientific inquiry skills:
  - observing using a microscope
  - detection of micro-organisms in materials studied
  - observing for detail, and asking questions regarding organisms observed
- technological problem-solving skills:
  - identifying alternative approaches to food processing and packaging
  - identifying problems which might occur in various approaches to food processing and storage
- decision-making skills:
  - gathering information about alternative technologies for eliminating disease-causing organisms in food supplies
  - evaluating costs and benefits of alternative technologies
  - identifying areas of decision making in the safe handling of food
  - evaluating safety standards: how safe is safe enough?

Attitudes
- awareness of the widespread nature of micro-organisms
- awareness of the role of scientific knowledge and technologies in maintaining a healthy food supply
- recognition of the need for safety standards to prevent the spread of disease through food
- safety attitude regarding the selection, preparation, and handling of food materials

6. **Evidence of Erosion**

Concepts
- effects of incremental changes over large periods of time
- weathering
- forms of erosion
- patterns of erosion and deposition
- soil water flow
- changing river courses and shorelines
- sediments
- glaciers and glacial movement
- effects of glaciation

Skills
- science inquiry skills, with particular emphasis on:
  - interpreting observations: finding patterns and relationships
  - predicting (based on extension of current trends and changes)
- field interpretation skills:
  - recognizing examples of different kinds of erosion
  - recognizing sediments and sediment patterns

- decision-making skills:
  - assessing the social impact of geological changes
  - recognizing problems that result from failure to consider effects of geological change
  - evaluating potential effects of measures designed to control processes of geological change

Attitudes
- awareness and appreciation of the effects of geological change over long periods of time
- respect for the power of geological forces
- appreciation of the dependence of humankind on the physical earth
- appreciation of the need to incorporate a knowledge of geological change in long-term land use planning

Grade Eight Program

1. **Solutions and Substances**

Concepts
- kinds of solutions
- properties of solutions and mixtures
- water based solutions
- solubility of materials
- speed of dissolving
- factors that affect solubility and/or speed of dissolving
- effect of solution strength on freezing point and boiling point

Skills
- science inquiry skills, with particular emphasis on:
  - observing
  - hypothesizing relationships between variables
  - inferring relationships between variables
  - graphing data
  - predicting based on extrapolation of trends
- technological problem-solving skills:
  - generating alternative approaches to solving a problem
  - evaluating approaches to solving a problem
- manipulative skills and techniques:
  - using filter paper
  - recovery of a solute by evaporation
  - distillation technique
  - growing crystals

Attitudes
- appreciation of the extent to which solutions are a part of living things, natural products and manufactured products
- awareness and appreciation of crystalline structures in solid materials
- awareness of solution chemistry as a practical science
- confidence in personal ability to investigate material properties and processes
- awareness of potential dangers of handling unknown materials

2. Energy and Machines

Concepts

- systems and subsystems
- design and function of mechanical systems
- the bicycle as a mechanical system
- gears and transmissions
- applications of mechanical systems
- power sources for mechanical systems
- forms of energy
- energy conversion and energy chains
- efficiency of design
- conservation of energy

Skills

- technological problem-solving skills:
  - analyzing mechanical systems: identifying subsystems and components within a system
  - "inventing" a device that makes efficient use of energy; e.g., rubber band powered car
  - evaluating alternative approaches to the solution of a given mechanical problem
  - identifying ways to improve the efficiency of a given system through lessening frictional losses and through improvements in design
  - troubleshooting: identifying the source of a problem in a mechanical system
- manipulative skills and techniques:
  - construction of an energy efficient device using simple materials; e.g., rubber band car

Attitudes

- awareness that practical problems can often be solved in multiple ways
- respect for the diversity of approach exhibited by others in their search for solutions to practical problems
- confidence in personal ability to solve practical problems
- awareness of the role of efficiency in good design

3. Consumer Product Testing

Concepts

- consumer product characteristics / consumer product quality
- consumer expectations
- defects and quality control
- product testing
- standards for product composition, packaging, labeling, and advertisement
- truth in advertising
- product safety
- conditions of use and product safety
- environmental and social impact

Skills

- science inquiry skills:
  - questioning
  - identifying problems
  - designing product testing experiments
  - predicting based on experimental data
- technological problem-solving skills:
  - identification of components within a system that have the potential to fail
  - identification and evaluation of product improvement alternatives
- decision-making skills:
  - identifying relevant and irrelevant information in relation to a product evaluation
  - gathering and compiling relevant information
  - evaluating products based on a single criterion
  - evaluating products based on multiple criteria
  - identifying areas in which public decision making is required
  - evaluating safety standards

Attitudes

- awareness of environmental impacts of consumer products
- awareness of ethical problems in use of animals in product testing research; e.g., in the testing of cosmetics
- awareness that a product may be safe for use in one application but dangerous to use in another
- awareness that products may affect different individuals in different ways
- confidence in personal ability to evaluate a product

4. Changes in the Earth's Crust

Concepts

- crustal movements
- earthquakes
- mountain building through folding and faulting
- volcanoes
- rock groups
- rock characteristics
- sedimentary rock formation
- fossil formation
- the fossil record
- relative time scale
- geological dating techniques

Skills

- science inquiry skills, with particular emphasis on:
  - interpreting observations: finding patterns and relationships
  - classifying (especially rocks)
  - predicting (based on extension of current trends and changes)
  - identifying and evaluating theoretical models

Attitudes

- awareness and appreciation of the effects of geological change over long periods of time
- respect for the power of geological forces
- appreciation of the dependence of humankind on the physical earth

- awareness of the role of theory in interpreting earth changes
- confidence in personal ability to interpret geological materials and changes

5. Growing Plants

Concepts
- plant structures: general characteristics and specializations
- plant propagation by vegetative reproduction
- flowering and seeds
- specialized varieties; plant breeding
- germination
- plant structures for absorption and transport
- plant growth in specialized environments; e.g., hydroponics, plant growth in space
- soil nutrients and fertilizers
- plant pests and diseases
- pollutants and pesticides

Skills
- science process skills:
  - experimenting to determine the effect of differing growth conditions
  - experimenting to compare the appropriateness of different varieties of plants to a particular growth environment
- manipulative skills and techniques:
  - growing plants from cuttings
  - performing a seed germination test
  - examining leaf structures using a microscope
  - growing plants in hydroponic solution
- interpretive skills:
  - identifying plant structures (macroscopic and microscopic)
  - identifying some common local plants

Attitudes
- respect for living things
- appreciation of the various roles of plants in sustaining human life
- awareness that the distribution and growth of plants is very much affected by human interventions and environmental modifications
- awareness that the survival and distribution of many plant forms is in jeopardy
- awareness that agricultural plant varieties are usually the product of intensive breeding
- confidence in personal ability to nurture healthy plants

6. Interactions and Environments

Concepts
- interaction of living things and their environments
- dependencies between living things: parasitism, commensalism and mutualism
- food chains and food webs
- energy flow within an ecosystem
- biotic factors
- light, soil and temperature needs of particular organisms
- niches, habitats and micro-environments
- communities of organisms
- effects of pesticides and herbicides
- effects of pollutants

Skills

- science inquiry skills:
  - performing a plant and animal census within a given study plot
- field interpretation skills:
  - recognizing common plants and animals found in the local area
  - recognizing examples of dependencies among living things
- decision-making skills:
  - gathering information on environmental quality
  - compiling and interpreting information on environmental quality
  - identifying environmental action alternatives
  - anticipating consequences of given environmental actions

Attitudes

- awareness of the complex interrelationships among living things and their environments
- awareness of the nature and extent of impacts on environments caused by human actions
- awareness of the need to monitor and manage environments
- concern and commitment for the maintenance of life-supporting environments

Grade Nine Program

1. Diversity of Living Things

Concepts

- plant and animal adaptations (review)
- diversity and specialization
- natural and artificial selection
- systems of classification (for all living organisms):
  - Linnaean system of classification
  - recent developments in classification
- variations in life cycle

Skills

- science inquiry skills:
  - classification by dichotomous grouping
  - observing structural features of living things
  - inferring adaptive value of particular structures and behaviours

Attitudes

- awareness and appreciation of the diversity of life forms
- awareness and appreciation of the interrelatedness of life forms
- recognition that systems of classification and nomenclature are human inventions (rather than something inherent in the materials being classified)
- appreciation of the usefulness of classification systems

2. Electromagnetic Systems

Concepts

- sources of electrical energy
- chemical sources of electricity
- generators
- electrical resistance
- series and parallel circuits
- household circuitry
- household appliances
- electrical energy consumption
- control circuitry

Skills

- science inquiry skills:
  - measuring electrical current
- technological problem-solving skills:
  - evaluating alternative designs for an electric battery
  - identifying ways to improve a simple model electric generator
  - analyzing electromagnetic devices: recognizing basic components and systems
  - interpreting a simple wiring diagram
  - inventing and constructing a simple electronic device to perform a given function; e.g., construction of a model burglar alarm, automatic door opener, or multiple speed windshield wiper

Attitudes

- safety attitude regarding the use of electrical devices
- awareness that practical problems can often be solved in multiple ways
- respect for the diversity of approach exhibited by others in their search for solutions to practical problems
- confidence in personal ability to solve practical problems

3. Heat Energy: Transfer and Conservation

Concepts

- heat and temperature (review)
- heat flow
- conduction, convection and radiation
- conduction rates
- insulation
- solar heating

Skills

- science inquiry skills:
  - detecting and measuring heat losses
  - comparing rates of heat conduction
- technological problem-solving skills:
  - evaluating properties of different materials (insulation vs conduction of heat)
  - evaluating different approaches to insulation
  - evaluating alternative techniques for circulating heat

Attitudes

- awareness of dangers of using flames in proximity to flammable materials
- commitment to the conservation of energy resources through efficiency of design and efficiency in energy use

4. Fluids and Pressure

Concepts

- the nature of fluids
- buoyancy
- density
- pressure
- effects of water pressure
- effects of air pressure
- fluid flow
- aerodynamic and hydrodynamic design
- pumping systems
- plumbing systems
- valves
- the heart, circulatory system and blood pressure

Skills

- science inquiry skills:
  - observing and describing fluids
  - measuring density of fluids, using an improvised hydrometer
- manipulative skills and techniques:
  - constructing an hydrometer
  - constructing a simple aneroid barometer
- technological problem-solving skills:
  - developing a diagram of a fluid system

Attitudes

- recognition of the ubiquitous presence of fluids in the biosphere: fluids in living things, fluids as a major component of the earth's surface, and fluids in technological devices
- appreciation of the aesthetic and functional values of aerodynamic and hydrodynamic design

5. Chemical Properties and Changes

Concepts

- common household substances as chemicals
- properties of materials
- chemical and physical changes
- acids and bases
- reaction rates
- factors that affect reaction rate: temperature, concentration and surface area

Skills

- chemical safety skills:
  - recognizing dangers
  - identifying appropriate safety precautions
- science inquiry skills, with particular emphasis on:
  - observing materials

- designing and performing simple identification tests of materials (designing experiments)
- inferring characteristics of materials
- testing ideas about the nature of chemical reaction; e.g., Law of Conservation of Mass

- technological problem-solving skills:
  - recognizing problems related to corrosion of materials
  - recognizing practical applications of processes studied

Attitudes

- awareness that all materials have a chemical composition of some kind
- awareness of dangers in handling certain groups of chemicals
- adoption of a prudent approach to the handling of all chemicals, especially those that are unfamiliar to the user
- awareness of consistency in chemical reactions: chemical events can be seen as predictable consequences of given conditions rather than as random or magical in origin

6. Environmental Quality: A Case Study

(Note: This case study could focus on any one of a wide range of environmental qualities. Examples include: air quality, water quality, sound/noise pollution, or acid rain. The text resource may develop only one of these topics, but teacher may opt to use other, locally developed material to produce an alternative topic.)

Concepts

- environmental quality
- environmental factors (review)
- concentration: parts per thousand, parts per million
- known and unknown effects of a given pollutant on living things
- knowledge of measurement technologies used in monitoring and measuring environmental quality (focus on one particular environmental factor)

Skills

- science inquiry skills:
  - using measurement instruments
  - constructing a simple measurement device to use in monitoring environmental quality
  - estimating concentration of a pollutant
- decision-making skills:
  - assessing the consequences of a given environmental problem
  - identifying relevant and irrelevant information
  - gathering and assessing information regarding possible corrective actions
  - conducting a survey
  - tabulating results of a survey
  - evaluating possible actions in terms of survey results

Attitudes

- awareness of the impact that environmental quality has on the health and well-being of living things
- awareness of the impact human action has had on environmental quality
- recognition of the limits to current knowledge regarding environmental quality
- appreciation of the problems created by limited knowledge of environmental quality (particularly in relation to public decision making)
- respect for the perspectives and viewpoints of others
- awareness of role and limits of scientific knowledge in areas of public decision making
- concern for and commitment to the maintenance of environmental quality

PROGRAM EMPHASES: DESCRIPTIONS AND OUTLINES

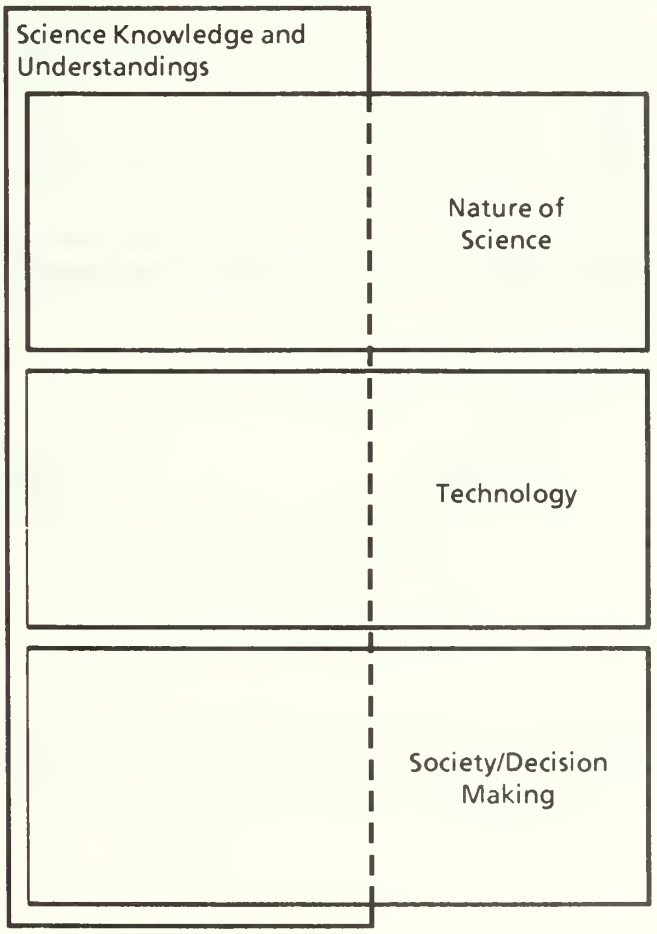
INTRODUCTION

The three program emphases are identified as:

Nature of Science
Technology
Society/Decision Making

These emphases are an integral part of the program; they are incorporated within each topic throughout each of the grades. The program emphases should not be regarded as additional or supplementary program content but rather as the context in which topics are presented. These contexts provide the basis for student understanding of the ways in which scientific knowlege is developed and used. They provide opportunities for examining the applications and implications of the science being studied; and at the same time, provide opportunities for attitude and skill development.

The following graphic illustrates the relationship of these emphases to the content of the program. Note that in each case the program emphasis is developed from the content rather than as a separate program entity. (For an analysis of the weighting to be given to each emphasis, please refer to the evaluation specifications later in this document.)



FOCAL QUESTIONS

The three program emphases can be seen as providing focus to the content of the program by attempting to answer the following questions:

Science Emphasis

What knowledge do we have in this area of study?

How do we know? How has our knowledge been acquired?

Technology Emphasis

How can we solve this practical problem?

How can we solve this problem more efficiently and effectively?

Society/Decision-Making Emphasis

What effects will this have?

What alternatives are there?

What actions should be taken?

Each of these groups of questions provides a perspective on the science which is studied.

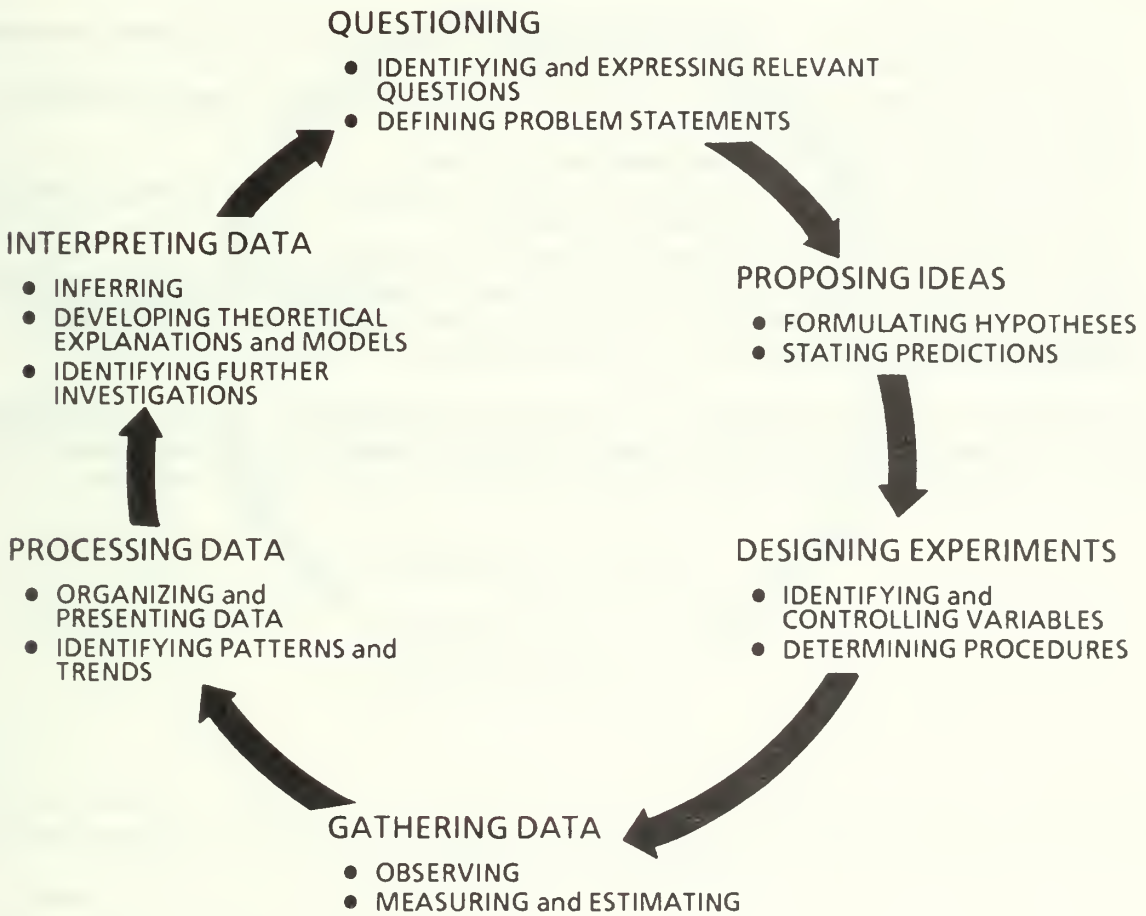
The outlines which follow provide an expanded analysis of the three program emphases. The knowledge, skills and attitudes outlined are part of the prescribed content of the program.

EMPHASIS 1: NATURE OF SCIENCE

Content that is presented with a Nature of Science emphasis will examine a body of knowledge in a particular content area and at the same time focus on how that knowledge has developed and how the study of that particular area illustrates the nature of science. The content will thus be used to develop a number of skills, attitudes and understandings regarding the nature of science.

Skills

Skills developed through this program emphasis are illustrated in the following inquiry process model:



Learning activities should provide opportunities to practise each of the individual skills identified in the above model. In addition, students should have opportunity to apply these skills in a holistic way, learning the skills of scientific inquiry as an overall process rather than as a fixed sequence of isolated skills.

Attitudes

Learning activities will support development of the following attitudes:

- concern for accuracy and evidence
- honesty and completeness in reporting and evaluating evidence
- open-mindedness in considering alternative ideas and interpretations
- critical mindedness in evaluating inferences and conclusions

Understandings

Learning activities will support the development of the following understandings:

- Science is comprised of an accumulated body of knowledge and also the processes by which that knowledge is developed.
- There is no single scientific method, but there are processes generally used by scientists in developing and verifying scientific knowledge.
- Scientific knowledge is based on observation and experiment.
- Scientific knowledge is not certain; much of scientific knowledge is based on theory, and it is subject to revision as additional evidence accumulates.
- A scientific theory may change and evolve over time, it may also be rejected.
- Scientific knowledge takes a number of forms. These include key concepts, hypotheses, and theories as well as conventions such as measurement systems and systems of classification.
- Material that purports to be scientific may not actually be so.

In addition to the above understandings, students will acquire a knowledge of processes of scientific inquiry. This knowledge will be evident in student's abilities to recognize the various steps within a inquiry process; also in their abilities to plan appropriate steps in investigations of their own.

EMPHASIS 2: TECHNOLOGY

Content that is presented with this emphasis will focus on the solution of practical problems through the application of related scientific knowledge and/or techniques. Content will be used to develop skills, attitudes, and understandings regarding the nature of technology.

Skills

Skills to be developed are those involved in the solution of practical problems as illustrated in the following technological problem-solving model:

Students should have opportunities to develop these skills though the solution of actual problems. Particular emphasis should be given to problems that incorporate hands-on activity in their solution.

In addition to the above skills, opportunities should be given for the development and reinforcement of general skills and abilities:

- ability to think creatively and inventively
- ability to apply critical thinking and evaluation skills
- psychomotor skills in the assembly and dissembly of simple constructions

Attitudes

Learning activities and materials will support development of the following attitudes:

- confidence in personal ability to solve practical problems
- initiative
- respect for alternative strategies for the solution of problems
- respect for efficiency in the solution of problems and in the use of energy
- respect for good design (both from an efficiency perspective and from an aesthetic perspective)
- interest in further learnings, particularly of scientific principles which underlie technologies studied

Understandings

Learning activities and materials will support the development of the following understandings:

- Applied science (or technology) is concerned with the solution of practical problems.
- Some of the same processes as used in pure science are also used in applied science, even though the aim of the activity is somewhat different.
- Developments in science have frequently followed from efforts toward the solution of practical problems.
- Developments of technologies have frequently resulted from advances in science.

In addition to the above, students will also acquire knowledge of:

- Basic scientific principles associated with such technologies studied.
- Ongoing work in the development and improvement of technologies.
- Practical knowledge of common materials.

EMPHASIS 3: SOCIETY/DECISION MAKING

Content that is presented with this emphasis will focus on the broad significance of the science and technology being studied. Attention will be given to impacts and decisions that must be made as a result of our present knowledge and practises. The overall aim for this emphasis will be to develop those skills, attitudes and understandings that lead to responsible application of scientific and technological knowledge.

Skills

Skills to be developed are those that lead to effective decision making. An overall strategy for decision making is illustrated in the following schematic diagram:

Attitudes

Learning activities will support development of the following attitudes:

- appreciation of the beauty and complexity of living things
- awareness of the interdependence of life forms
- awareness of resource uses and their impact on the environment
- awareness of the need for resource conservation
- awareness that the solution of one problem may result in the creation of another problem (sometimes of greater concern than the original problem)
- awareness that the solution of problems may involve many ways of thinking and knowing, not just scientific or technological ones
- respect for the perspectives and viewpoints of others

Understandings

Learning activities will support the development of the following understandings:

- Events and actions do not usually have isolated single consequences: technology may be developed for a specific purpose but its effects often extend much further.
- Science and technology have significant impacts:
  - on human welfare
  - on the course of human history
  - on the use of resources
  - on environments and on the health of living organisms in those environments
  - on intellectual and cultural developments.
- Often the products of science and technology are accepted and used by society before the full extent of benefits or problems resulting from their use can be fully known.
- The attitude that science and technology can solve all problems gives people a false sense of security.
- Science and technology advance in response to societal needs and concerns.
- Scientific and technological considerations play an increasingly important role in public decision making.
- Science and technology decisions may involve trade offs between different goals.
- Science and technology have created a large number of specialized employment opportunities.
- Continuing advances in science and technology contributes to the social and economic development of Canadian society.
- Science and technology can affect individual lifestyles and the individual, in turn, can contribute to science and technology.

SUGGESTED OPTIONS

This is a preliminary listing only. The final listing of optional topics will likely be reduced in number in accord with anticipated demands and resource availability.

SPACE TECHNOLOGY

OBSERVING THE NIGHT SKY

INVENTIONS

AERONAUTICS AND SPACE FLIGHT

EXCURSIONS IN MEASUREMENT

SOUND SYSTEMS

LIGHT

METEOROLOGY

ENVIRONMENTAL MONITORING AND MANAGEMENT: A CASE STUDY

OCEANOGRAPHY

RESOURCE EXTRACTION TECHNOLOGIES

RENEWABLE ENERGY SOURCES

Note that grade level placement of these topics has not been specified. Comments and suggestions regarding grade level placement are requested in the response guide distributed with this document.

JUNIOR HIGH SCIENCE
SUGGESTED OPTIONS

SPACE ENVIRONMENTS AND TECHNOLOGIES

Concepts
- space as a frontier for exploration and development
- space environments
- environments of planets, moons and asteroids in the solar system
- life support systems
- communication technologies
- imaging and remote sensing
- resources in space
- benefits and costs of space technology

Skills
- science inquiry skills, with particular emphasis on:
  - observing a closed system environment; e.g., sealed aquarium or terrarium
- technological problem-solving skills:
  - identify specific problems in maintaining life supporting environments in space
  - identify special problems in carrying out work in space
  - proposing alternative ways in which problems could be solved
  - constructing diagrams and models of proposed means for solving specific problems in space
  - evaluate alternatives in terms of efficiency and effectiveness
- decision-making skills:
  - gather information about space technologies
  - evaluate costs and benefits of space technologies

Attitudes
- respect for the complexity of space technologies
- awareness of benefits and potential benefits of space technology
- awareness of the possibilities and consequences of error in space technologies
- confidence in personal ability to comprehend technologies

OBSERVING THE NIGHT SKY

Concepts
- development of astronomy as a science
- observational astronomy
- evidence, interpretation and theory
- development of knowledge regarding position and motion of bodies in space
- solar system: planets, moons, asteroids, stars, comets
- star systems
- distinctions between astronomy and astrology:
  - purposes
  - processes

- observation and the observer's point of view:
  - selective observation and perception
  - selective reporting of "facts"
- objectivity and subjectivity in observation and reporting
- predictions and self-fulfilling prophecy
- interpreting the unusual: unidentified objects

Skills
- science inquiry skills:
  - sight astronomical bodies, using a telescope
  - report observations accurately
  - identify alternative explanations for given phenomena
  - distinguish between scientific and non-scientific reporting
  - identify biases in reporting

Attitudes
- concern for accuracy and evidence
- open-mindedness in considering alternative ideas and explanations
- critical mindedness in examining inferences and conclusions

INVENTIONS

Concepts
- function
- design
- materials
- power sources
- systems and subsystems (review)
- effectiveness
- efficiency
- historical development of selected examples

Skills
- research skills:
  - locate information on particular technological devices
  - interpret information
  - prepare and presenting reports
  - prepare and present for an "inventions fair"
- technological problem-solving skills:
  - building devices to perform a given function
    - idea generation
    - construction and assembly skills
    - troubleshooting
  - evaluate a technological device: effectiveness and efficiency

Attitudes

- confidence in personal ability to solve practical problems
- initiative
- respect for alternative approaches to the solution of problems
- respect good design (both from an efficiency perspective and from an aesthetic point of view)
- recognition of technology as the search for solutions to practical problems

AERONAUTICS AND SPACE FLIGHT

Concepts

- forces operating on an aircraft: lift, gravity, thrust and drag
- streamlining and reduction of drag
- control systems
- monitoring systems:
  - elevation
  - position and motion
- safety and aircraft design
- propulsion systems for aircraft
- propulsion systems for space vehicles
- trajectories and orbits
- space vehicles
- space stations and space laboratories

Skills

- technological problem-solving skills:
  - construction and testing of model airplanes
    - wind tunnel (fan) tests
    - flight tests
  - construction and testing of model rockets

Attitudes

- awareness of the scope of attention required to ensure safety in airplanes and space vehicles
- appreciation of the aesthetic value as well as functional value of good design

EXCURSIONS IN MEASUREMENT AND MAPPING

Concepts

- knowledge of measurement devices
- SI system of measurement (review)

Skills

- science inquiry skills, with particular emphasis on:
  - questioning
  - observing for detail
  - reading measurement scales
  - measurement of distance and height by indirect means
  - estimating populations
  - estimating surface areas of natural materials
  - measuring volumes by displacement
  - recording field observations and measurements
  - performing a count of objects in a small field study plot
  - mapping objects in a small field plot
- manipulative skills and techniques related to use of measurement devices

Attitudes

- respect for precision
- appreciation of human ingenuity and skill in the development of technologies used in measurement
- confidence in personal ability to measure and to estimate

SOUND SYSTEMS

Concepts

- characteristics of sound: loudness, pitch, quality
- factors that affect pitch of a vibrating material
- specialized animal adaptations for sound production and detection
- functions of sound for humans and for other living things
- the human ear
- speakers and microphones: basic principles
- sound propagation theory: sound "waves"
- resonance and reverberation
- sound conduction through different materials
- speed of sound
- echos and echolocation
- musical instruments: principles of sound production
- sound quality and wave characteristics

Skills

- science inquiry skills:
  - observe and describe sounds
  - measure loudness of sounds
- manipulative skills and techniques:
  - produce sounds of high and low pitch using simple materials
  - construct improvised musical instruments
  - dissemble and analyse surplus audio equipment; e.g., microphones and speakers

Attitudes
- appreciation of the diversity of sounds and their contribution to human experience
- awareness of the various roles that sounds play in the adaptation of animals (for locating food, for avoiding danger, for socialization and for navigation)
- appreciation of the intricacte yet basic simplicity of the human ear
- confidence in personal ability to identify characteristics of sound

LIGHT

Concepts
- effects of light
- reflection of light
- refraction and colour
- colour phenomena and everyday materials
- scattering and absorption
- angle of reflection and refraction
- convex and concave mirrors
- convex and concave lenses
- real images
- cameras
- special effects and illusions
- optic fibres

Skills
- science inquiry skills:
  - observe and describe light beams
  - measure angles of light beams
  - prediction of path of light beams based on knowledge of principles of light
- manipulative skills and techniques:
  - create optical effects and illusions

Attitudes
- appreciation of sight
- recognition that sight is not infallible: that the appearance of real objects may be influenced by the manner in which they are viewed
- appreciation of technologies used in the capture and transmission of images

METEOROLOGY

Concepts
- properties of air (review)
- heat distribution by season and by characteristics of the earth surface
- air masses
- heat absorption by air masses
- fronts

- motion of air masses
- precipitation
- storms and dangerous weather phenomena
- meteorological instruments
- principles of weather prediction

Skills
- interpretive skills:
  - recognize and interpret cloud types
  - interpret weather maps
- technological problem-solving skills:
  - construct of simple measurement instruments
  - use and improve the accuracy of constructed instruments

Attitudes
- respect for the power of forces of nature
- appreciation of the need for accuracy in reporting as a basis of understanding weather

ENVIRONMENTAL MONITORING AND MANAGEMENT: A CASE STUDY

(Note: This case study could focus on any one of a wide range of environments. The choice of environment should be made at the school level in accord with resources available. Example environments include: a schoolyard, an aquatic environment, a forested area, a ravine or valley. The environment chosen should be different from that chosen for unit six of the grade eight program.)

Concepts
- environmental factors
- conditions for species survival
- factors which favour the dominance of particular species
- niches
- species within the environment
- environmental relationships
- environmental impacts

Skills
- science inquiry skills:
  - measure abiotic factors in a given environment: temperature, light, moisture, nutrients, pH
  - map a study site
  - population counts/census taking
  - map populations in relation to physical features of environment studied
  - hypothesize possible relationships between factors within an environment and populations within that environment
  - infer relationship between the distribution of organisms in a given study site and the variation in abiotic factors within that study sight
  - identify human interventions in the natural environment
- decision-making skills:
  - identify alternative actions in managing the environment
  - assess long-term consequences of those alternative actions to survival of populations currently represented in that environment

Attitudes

- awareness and appreciation of the complex interrelationships between living things and their environments
- awareness of the nature and extent of impacts on environments caused by the influx of waste materials
- awareness of the need to monitor and manage environments
- awareness of the role that individuals can play in environmental decision making

OCEANOGRAPHY

Concepts

- distribution of marine environments
- characteristics of marine environments
- ocean floor geography and geology:
  - continental shelves, basins, rises and trenches
  - ocean floor spreading
  - sedimentation patterns
- forms and major groups of marine life
- distribution of life forms in marine environments
- food chains in marine ecosystems
- seafood
- fishing and "harvesting" techniques
- human impacts on aquatic populations

Skills

- observe marine animals (through use of films and aquaria)

Attitudes

- appreciation of the effect of oceans on atmosphere and adjacent land
- appreciation of dependence on the sea as a major food source
- value the diversity of life forms found in oceans

RESOURCE EXTRACTION TECHNOLOGIES

Concepts

- resource location:
  - surface interpretation: prospecting and surveying
  - subsurface interpretation: sampling and seismology
  - aerial photography and remote sensing
- evaluate economic value of the resource
- resource extraction:
  - surface mining techniques
  - subsurface mining
  - drilling for oil and gas
  - recoverable and non-recoverable deposits
  - techniques for enhancing the efficiency of extraction
- refinement of resources
- resource conservation

- environmental impacts and reclamation:
  - reversible and irreversible changes
  - surface modifications
  - generation of air and water pollutants
  - effects on populations
  - reclamation techniques

Skills
- science inquiry skills:
  - observe samples of economic minerals
  - distinguish samples of differing composition
  - observe and recognize environmental impacts
- decision-making skills:
  - recognize alternatives regarding approaches to resource extraction
  - evaluate alternatives in terms of short and long term values
  - anticipate environmental impacts of resource extraction activities
  - recognize relationships between personal lifestyle and resource use

Attitudes
- appreciation of the concept of non-renewable resources
- recognition of the dependence of lifestyle on the use of resources
- value efficiency in energy use
- recognize personal responsibility in energy and resource

RENEWABLE ENERGY SOURCES

Concepts
- energy
- greenhouse effect
- solar energy
- factors affecting solar energy received
- solar energy collectors
- wind energy
- wind energy collectors
- biomass energy

Skills
- science inquiry skills:
  - measure solar and wind energy
- technological problem-solving skills:
  - recognize problems in collecting and using renewable forms of energy
  - construct a model wind energy or solar energy collector
  - improve the efficiency of a solar or wind energy device
  - evaluate designs for solar energy collection
- decision-making skills:
  - recognize alternatives in different forms of energy that might be used
  - recognize the role of public decision making in determining the forms of energy used
  - identify personal decisions that can affect energy use

Attitudes

- value efficiency in energy use
- recognize and value human ingenuity in the solution of practical problems in the collection of energy
- appreciate the relative advantages of renewable energy use
- recognize personal responsibility in energy use

D. EVALUATION SPECIFICATIONS

In the pages which follow, each year of the program has been analyzed with respect to:

1. Curriculum Emphases

   This section indicates the unit weightings for each of the three program emphases.

   Nature of Science
   Technology
   Society / Decision Making

2. Learning Domain

   This section provides an analysis of unit weightings on concept, skill and attitude development.

3. Unit Weightings

   This section provides an analysis of weightings to be given to each unit within each year of the program.

JUNIOR HIGH SCIENCE EVALUATION SPECIFICATIONS
PART 1: ANALYSIS BY CURRICULUM EMPHASIS

	Nature of Science	Technology	Society/ Decision Making
GRADE SEVEN PROGRAM			
1. Characteristics of Living Things	75	10	15
2. Structures and Design	20	65	15
3. Force and Motion	60	30	10
4. Temperature and Heat Measurement	40	45	15
5. Micro-organisms and Food Supplies	30	35	35
6. Evidence of Erosion	65	15	20
Grade 7 Emphasis	48.3%	33.3%	18.3%
GRADE EIGHT PROGRAM			
1. Solutions and Substances	70	20	10
2. Energy and Machines	30	60	10
3. Consumer Product Testing	35	30	35
4. Changes in the Earth's Crust	70	15	15
5. Growing Plants	40	45	15
6. Interactions and Environments	65	10	25
Grade 8 Emphasis	51.6%	30%	18.3%
GRADE NINE PROGRAM			
1. Diversity of Living Things	75	10	15
2. Electromagnetic Systems	30	60	10
3. Heat Energy: Transfer and Conservation	45	40	15
4. Fluids and Pressure	35	50	15
5. Chemical Properties and Changes	65	25	10
6. Environmental Quality: A Case Study	35	15	50
Grade 9 Emphasis	47.5%	33.3%	19.2%
Total Program Emphasis	49.1%	32.2%	19.6%

JUNIOR HIGH SCIENCE EVALUATION SPECIFICATIONS
PART 2: ANALYSIS BY LEARNING DOMAIN

	Concepts	Skills	Attitudes
GRADE SEVEN PROGRAM			
1. Characteristics of Living Things	55	35	10
2. Structures and Design	40	45	15
3. Force and Motion	55	35	10
4. Temperature and Heat Measurement	55	35	10
5. Micro-organisms and Food Supplies	40	45	15
6. Evidence of Erosion	55	35	15
Grade 7 Emphasis	50.0%	38.3%	11.7%
GRADE EIGHT PROGRAM			
1. Solutions and Substances	55	35	10
2. Energy and Machines	45	45	10
3. Consumer Product Testing	40	45	15
4. Changes in the Earth's Crust	60	30	10
5. Growing Plants	45	40	15
6. Interactions and Environments	45	40	15
Grade 8 Emphasis	48.3%	39.2%	12.5%
GRADE NINE PROGRAM			
1. Diversity of Living Things	55	30	15
2. Electromagnetic Systems	45	45	10
3. Heat Energy: Transfer and Conservation	60	30	10
4. Fluids and Pressure	55	35	10
5. Chemical Properties and Changes	60	30	10
6. Environmental Quality: A Case Study	40	40	20
Grade 9 Emphasis	52.5%	35.0%	12.5%
Total Program Emphasis	50.5%	37.5%	12.2%

JUNIOR HIGH SCIENCE EVALUATION SPECIFICATIONS
PART 3: UNIT WEIGHTINGS

	% Weighting
GRADE SEVEN PROGRAM	
1. Characteristics of Living Things	18
2. Structures and Design	20
3. Force and Motion	16
4. Temperature and Heat Measurement	12
5. Micro-organisms and Food Supplies	19
6. Evidence of Erosion	15
GRADE EIGHT PROGRAM	
1. Solutions and Substances	16
2. Energy and Machines	17
3. Consumer Product Testing	16
4. Changes in the Earth's Crust	17
5. Growing Plants	17
6. Interactions and Environments	17
GRADE NINE PROGRAM	
1. Diversity of Living Things	17
2. Electromagnetic Systems	20
3. Heat Energy: Transfer and Conservation	12
4. Fluids and Pressure	17
5. Chemical Properties and Changes	17
6. Environmental Quality: A Case Study	17

Note: These weightings reflect the intended emphasis to be phaced on each unit. The figures may also be read as the intended number of instructional hours for each of the units.

APPENDIX 1

KEY EXPERIENCES

(Excerpt from draft curriculum guide)

The outlines that follow identify suggested activities for use in support of the required program. The activities are not mandatory; rather, they are identified as a support to teachers in planning for effective instruction. In most cases these activities correspond to the activities that will be found in the student textbooks now under development. This listing will be updated as resource development proceeds.

Note that the final form of this listing will include a cross-referencing to basic resources. The listing may also be expanded to include recommended elective activities: that is, those activities that may be used selectively with groups of students according to their needs and interests.

In most instances, the activities appear following concept statements identical to those outlined in the draft program. In some cases, the concept statements have been abridged or combined.

As key experiences, the activities identified are those deemed to be appropriate for all students. They are intended to provide a practical basis for concept, skill and attitude development; but for full development of the program, other kinds of activities will be required. Reading, viewing, listening, speaking and other means of receiving, processing and communciating ideas are also important activities in the program.

Note that in most cases the activities have been described in generic form: this open-ended format provides scope for a variety of equivalent activities. The student resources will in most cases be much more specific in the activities outlined, but teachers will be encouraged to use the flexibility of the program to their students' best advantage. The choice of activities and the form in which they are presented remain the professional responsibility of the teacher.

Grade Seven

The following learning activities are suggested in association with the grade seven program.

1. CHARACTERISTICS OF LIVING THINGS

General characteristics of living things
- classify materials as living and non-living (include materials that may be hard to classify; e.g., dormant materials such as seeds; also materials, such as the individual leaves of a plant that may not be sufficiently complete to survive on their own

Variation among living things
- observe and compare particular organisms; identify ways in which the organisms are similar and ways in which they are different
- infer the adaptive value of different structures
- observe variation within a species; e.g., variation within a group of leaves from the same type of plant

Growth patterns
- observe and describe different patterns of growth in organisms

Structural adaptations
- observe and interpret animal adaptations to serve particular functions; e.g., digestion, respiration, locomotion, reproduction
- measure respiration and heart rates
- design and conduct an investigation in which heart and/or respiration rates are measured in relation to physical activity
- measure lung capacity and the heights, ages and weights of individuals; chart and graph the results

Stimulus and response
- observe variation in responsiveness to stimuli for various organisms
- observe variation in human responsiveness to stimuli
- design and carry out an experiment in human responses to sensory stimuli

Behavioural adaptations
- observe and interpret responses of organisms to changing environmental conditions
- observe, interpret and describe specialized responses of particular organisms to given conditions

2. STRUCTURES AND DESIGN

Design in the natural world
- describe examples of design observed in nature
- infer functional value of designs observed

Design in the built environment and in manufactured things
- observe and describe patterns, shapes and overall designs of built materials
- observe and identify examples of alternative designs for the same function
- observe and classify functions of various kinds of built objects

Strength of materials
- measure and compare tensile strength of materials; e.g., compare the tensile strength of different papers or of different threads
- measure the compression test of a material; e.g., chalk or a sugar cube

Tension and compression (qualitative treatment)
- analyze points of tension and compression in a simple design; e.g., model bridge
- identify points at which a given structure is most likely to fail

Design as a factor in strength of structures
- construct an I beam and an L shaped beam out of cardboard or paper
- measure the load strength of an I beam and an L shaped beam
- compare the load strength of two or more designs for a load bearing structure

Design of bridges and buildings
- build a model structure to satisfy a given design requirement
- compare alternative designs for a structure; evaluate effectiveness and efficiency of alternative designs

Hinged systems (in constructions and in living things)
- observe and identify hinged components within structures
- observe the design of different kinds of hinges

Choice of materials to suit a function
- compare the use of several kinds of materials in a given application

3. FORCE AND MOTION

Kinds of forces; e.g., mechanical, gravitational, magnetic, frictional, buoyant, electrostatic
- identify examples of different kinds of forces and the effects of those forces (through analysis of practical experiences)

Measurement of forces
- construct a force meter using available materials
- estimate and measure forces

Gravity as a force
- measure the gravitational force on objects, using conventional measuring instruments and using student-constructed force meters

Relationship of mass and weight
- use and compare instruments for the measurement of force and the measurement of mass

Factors that affect friction
- determine factors that affect friction (through experimentation)
- design and build a device that operates on a limited input of energy
- improve the energy efficiency of a constructed device through modification of its design or through use of alternative materials
- identify sources of friction in mechanical systems; identify specific improvements that could enhance the efficiency of a given mechanical system

Idealized non-frictional systems
- plot pathways of moving objects
- predict pathways of moving objects

Action/reaction
- identify (analyze) action-reaction pairs, identifying forces, actions and reactions

4. TEMPERATURE AND HEAT MEASUREMENT

Accuracy in temperature measurement
- estimate temperatures based on subjective measurements
- measure temperatures by different means and compare accuracy of temperature measure
- measure, record and graph the change in temperature of a liquid as it is heated

Calibration
- construct and calibrate temperature measurement devices (this activity may overlap the following two activities)

Liquid thermometers
- construct, calibrate and evaluate a temperature measurement device that works on the principle of liquid expansion

Air thermometers
- construct, calibrate and evaluate a temperature measurement device that works on the principle of expansion of a gas

Specialized thermometers; e.g., thermocouples, bimetallic strips, liquid crystals
- view, use and evaluate of various types of specialized thermometers
- analyze advantages and disadvantages of different kinds of thermometers in relation to different applications

Heat
- measure temperature changes of a liquid based on addition of a given quantity of heat
- measure and compare temperature changes through activities in which materials at different temperatures are brought together and allowed to come to a common temperature

Heat generation from different sources
- observe heat energy produced from a mechanical source
- observe heat energy produced from a chemical source
- observe heat energy produced from an electrical source

Energy content of fuels
- measure heat content of a given quantity of fuel

5. MICRO-ORGANISMS AND FOOD SUPPLIES

Micro-organisms
- observe micro-organisms, using a microscope
- describe, and classify sample micro-oganisms (introductory treatment only)
- prepare wet mount slides

Habitats for micro-organisms
- observe micro-organisms in/from different habitats
- prepare or select appropriate media for culturing micro-organisms
- culture micro-organisms (note that safety is a prime consideration in selecting appropriate activities)
- observe growth rates in populations of micro-organisms
- observe the effects of specific materials and procedures on the survival of micro-organisms

Roles of micro-organisms in natural systems
- observe effects of micro-organisms on the media in which they live

Roles of micro-organisms in food production
- carry out or simulate a food preparation involving the use of micro-organisms; e.g., yeast or yogurt bacterial culture (note that safety is a prime consideration in selecting appropriate activities)

Role of micro-organisms in food spoilage
- observe food spoilage effects of micro-organisms

Technologies for preparing, preserving and protecting human food
- carry out specific procedures for preparing, preserving and protecting food supplies; i.e., sterilization, drying, chemical treatments
- view additional procedures used in preparing, preserving and protecting food supplies
- compare the effectiveness of different techniques for preserving particular food materials

Safety standards for preparing and handling of food
- observe and analyze information provided on food labels
- identify (analyze) potential hazards in food preservation techniques

Issues regarding the setting of appropriate safety standards
- simulation or case study activity in which a food safety standard must be set and defended

Problems in regulating and enforcing safety standards
- simulation or case study activity to illustrate problems in monitoring and enforcement

6. EVIDENCE OF EROSION

Effects of incremental changes over large periods of time
- observe changes occurring in an actual stream or on a stream table over a period of time
- view changes in landscape by reference to pictures or maps representing different views over extended period of elapsed time; e.g., 50 or 100 years

Weathering
- observe of effects of freezing water (through experimentation and/or field observation)
- observe of materials in which chemical and biological weathering have taken place

Forms of erosion
- observe different effects of erosion and infer processes which have led to those effects
- simulate forms of erosion or view visual materials that illustrate those forms of erosion

Patterns of erosion and deposition
- through stream table study or through a field study, observe patterns of erosion and deposition over time
- observe and infer susceptibility to erosion (based on such factors as slope, subsurface composition and surface cover)

Soil water flow
- observe movement and spread of water through initially dry soil
- measure and compare movement of water through different soil materials

Sediments
- examine, describe and classify sediments
- compare sedimentation rates of different materials

Glaciers and glacial movement
- observe deformity of ice as a result of pressure over time
- observe visual materials in which movement of glaciers can be inferred

Effects of glaciation
- simulate activity in which students observe a melting model glacier
- observe effects of glaciers through visual materials and/or a field study

Grade Eight

The following learning activities are suggested in association with the grade eight program.

1. SOLUTIONS AND SUBSTANCES

Solutions and mixtures
- mix various materials with water and observe the resulting mixtures and solutions
- compare various kinds of solutions and mixtures

Kinds of solutions / properties of solutions
- observe and classify examples of solutions
- observe the increase in mass and density of a solution as solute is added

Solubility of materials
- observe through experimentation that the solubility of many materials have defined limits
- observe that the limits of solubility can be influenced by experimental conditions
- through experimentation, identify factors (conditions) that influence solubility
- experiment to determine the effects of various factors on solubility of a material; i.e., temperature, choice of solvent (other factors may also be explored)
- measure the solubility of a material and display the results by drawing a graph

Speed of dissolving
- observe change in speed of dissoluting as saturation is approached
- experiment to determine the effects of various factors on the speed of dissolution; i.e., temperature, particle size and mechanical movement (other factors may also be explored)
- design a method to maximize the speed of dissolution

Separation of materials
- separate undissolved materials from solution, using filtration techniques
- evaluate the effectiveness of different filter materials for specific applications
- recover a solute by evaporation
- observe crystal formation and growth
- compare the effectiveness of alternative techniques for the separation of materials in particular applications; e.g., purification of drinking water

Effect of solution strength on freezing point and boiling point
- observe the effect of solution strength on freezing point and boiling point of solutions
- design a solution that will not freeze (or boil) until reaching a specified temperature (based on the above principle)

2. ENERGY AND MACHINES

Systems and subsystems
- analyze subsystems and components in a simple mechanical system; e.g., a mechanical pen, a pencil sharpener, a bicycle

Design and function of mechanical systems
- compare alternative designs for the same mechanical purpose; e.g., (1) compare propulsion systems in different kinds of toy cars, (2) compare the design and function of different kinds of bicycles, (3) compare different kinds of floor cleaning implements, (4) compare different can openers (5) compare paper fasteners

Power sources for mechanical systems
- identify the source of mechanical power in some common household devices and/or mechanical toys

Gears and transmissions
- examine the power transmission system in a bicycle; identify points at which force is transferred from one component to another
- analyze the effect of gear ratios on the rate of rotation of the rear wheel of a bicycle (with respect to rate of rotation of pedals)
- build a mechanical system in which the rotation of two shafts is linked mechanically so that the rate of rotation of the two shafts is different (belt driven system and/or gear driven system)
- build or adapt a mechanical system so as to provide for different turning ratios between a driving and a driven shaft

Forms of energy
- identify alternative forms of source energy that can be used to operate a simple mechanical system

Energy conversion
- use and recognize examples of simple machines (wheel and axle, pulleys, levers, inclined planes)
- develop or adapt a mechanical system so that it can operate on more than one form of energy input; e.g., a device that can be adapted to use the energy of a falling weight or use the energy of a stretched rubber band

Efficiency of design
- "invent" and construct a device that makes efficient use of energy; e.g., rubber band car, air car
- improve the energy efficiency of a device by "troubleshooting"; i.e., diagnosing and improving details related to construction, to choice of materials or to method of use
- identify points and sources of friction in constructed devices
- identify changes in the design of a device that would improve its overall energy efficiency
- identify improvements in design that can increase safety and ease of operation
- identify improvements in design that can minimize material costs and construction time

Conservation of energy
- interpret information on energy efficiency of different devices or products; e.g., fuel consumption of automobiles, electrical power consumption of a household appliance
- identify environmental effects of inefficiency in use of energy or materials

3. CONSUMER PRODUCT TESTING

Consumer product characteristics/consumer product quality

- identify function of a given consumer product and conditions under which the product may be used
- analyze characteristics of a given consumer product (e.g., texture, colour, hardness); identify those that are important to the effectiveness of the product

Defects and quality control

- for a sample product, identify possible defects in material and design; analyze and identify ways in which a product could fail; analyze and identify ways in which defects may not be immediately visible

Product testing

- design and carry out tests on selected characteristics of particular products
- conduct a controlled investigation in which two or more examples of a given product are compared with respect to specified characteristics
- prepare a presentation in which two or more examples of a given product are compared
- critically examine experimental methods used in testing a given product

Product design

- design a product that will serve a given purpose or solve a given problem. (Activities in this category may include the making of concept drawings as well as the construction of prototype products. At least one activity should involve an actual construction.)
- test and evaluate the product
- prepare an advertisement for the product and also a critical evaluation of the product that might appear in a consumer report

Truth in advertising

- analyze product advertisements, identify testable and non-testable claims of product advertisements

Product safety and use

- analyze and identify safety hazards that may result if product characteristics are different than what is expected
- write and defend a sample product design standard
- analyze and identify safety hazards that result when a product is used in ways other than those for which it was designed
- write a sample set of instructions on the use of a product
- identify examples of standards for consumer products used

Environmental and social consequences

- compare alternative products or devices that serve a similar purpose: focus on the energy and the resources that are required to produce that product or device; e.g., consider a manual can opener versus an electric can opener
- analyze social and environmental desirability of a line of products (the example may be a hypothetical product rather than an actual one)

4. CHANGES IN THE EARTH'S CRUST

Crustal movements
- interpret diagrams showing ocean floor spreading and continental drift
- interpret pictures that provide evidence of crustal movement

Mountain building through folding and faulting
- interpret folding and faulting by means of diagrams and models

Volcanoes
- locate general distribution of volcanoes on a world map
- interpret changes caused by a volcano, based on information provided through pictures

Rock groups
- observe samples of rocks in major groups
- observe similarities and differences between metamorphic rocks and sedimentary rocks from which they are formed
- classify rocks by origin

Rock characteristics
- identify major crystalline materials (minerals) from which igneous rocks are formed
- identify common rocks

Sedimentary rock formation
- observe sedimentation of fine gravel, sand and clay from a jar of water
- interpret relative ages of rocks in sedimentary layers

Fossil formation
- simulate fossil formation
- observe fossils and infer characteristics of original organisms

Relative time scale
- create a time scale; e.g., on an adding machine tape

5. GROWING PLANTS

Plant structures: general characteristics and specializations

- observe patterns and variations in structure of vascular plants; infer function of structures and adaptive value of variations
- observe cellular structures of plants by examination of sections, using microscope; i.e., sections of leaves, stems, roots and flowering parts
- observe and infer life processes of plants; i.e., osmosis, conduction, transpiration, gas exchange, photosynthesis

Plant propagation by vegetative reproduction

- propagate plants from leaf and stem cuttings
- propagate plants from tubers and bulbs

Flowering and seeds

- dissect flowers, identifying flower parts and functions
- observe and estimate numbers of seeds produced by some common local plants
- observe and identify some local plants

Specialized varieties; plant breeding

- observe different varieties of a plant produced by selective breeding
- construct and interpret charts indicating results of three generations of cross-breeding based on a dominant and a recessive variety

Germination

- conduct a germination study, compute germination rate based on results obtained

Soil nutrients and fertilizers

- test soil for pH; compare the use of inorganic and organic fertilizers

Monitoring and managing plant growth

- conduct a plant growth investigation in which plant growth response is observed in relation to variation in growth conditions. This investigation may focus on (but is not limited to) the following:
  - manipulation of light conditions: photoperiod, intensity of light, quality of light to suit needs of plants
  - addition of measured quantities of fertilizers and/or growth supplements to plants
  - growth of plants in hydroponic solution
- monitor and measure soil moisture and soil fertility
- maintain a growth record of a plant from germination to flowering, noting all care procedures followed

Plant pests and diseases

- observe and recognize symptoms of plant stress
- observe and infer possible causes of plant stress
- observe and identify some common plant pests
- observe the results of application of a plant herbicide, pesticide or biological control. Note that safety will be a prime consideration in this activity; the example(s) chosen should be non-toxic to humans
- identify alternatives for pest control and identify the relative merits of these alternatives in a particular situation (this may be done through a simulation or case study activity)

6. INTERACTIONS AND ENVIRONMENTS

(Note: Where possible the activities should involve actual studies of living things. For practical reasons, many of the activities will have to be based on observation of film, video or illustrated text resources.)

Interdependencies of living things
- observe distribution patterns of living things and hypothesize possible relationships and interactions
- observe and infer animal activities that indicate dependencies for food or protection
- observe and infer examples of specific dependencies between living things: parasitism, commensalism and mutualism

Food chains, food webs and energy flow
- observe and infer food chain relationships in an ecosystem
- classify animals as producers, consumers and decomposers
- predict the effect of minor changes in the characteristics of an animal or plant on the ability of that plant or animal to survive in a given environment

Abiotic factors
- identify, observe and measure abiotic factors in a given environment
- classify environments according to abiotic factors

Light, soil and temperature needs of particular organisms
- observe distribution of a particular plant or animal in relation to changes in abiotic conditions

Niches, habitats and micro-environments
- observe plants and animals that are found only in specialized habitats; infer the relationship of the plant or animal to its environment

Communities of organisms
- complete population counts of organisms within a study plot
- identify producers, consumers, and decomposers within an environment

Effects of pollutants
- predict environmental consequences of the addition of specified pollutants

Grade Nine

The following learning activities are suggested in association with the grade nine program.

1. DIVERSITY OF LIVING THINGS

Plant and animal adaptations
- observe plant and animal structures and interpret functions of those structures
- observe and interpret groups of plants or animals that are similar in their overall structure but with some identifiable variations; infer the adaptive value of those variations in structure

Diversity and specialization
- interpret conditions in given environments which affect the survival and distribution of particular plants and animals in those environments
- observe and interpret environmental selection in plant and animal populations (including both "natural" and human-controlled selection processes)
- observe and interpret specialized relationships between particular animals; e.g., mutual dependencies, symbiosis, mimicry
- compare the diversity of plant and animal populations in human-controlled and natural environments

Classification
- classify materials, plants or animals by dictohomous grouping
- develop and use a dichotomous key
- use a key in the identification of local plants or animals
- classify organisms by major scientific groups: kingdom and phylum (and in some cases by class as well)

Characteristics of major groups of living things
- observe and interpret external and internal structures of major plant and animal groups (through a detailed study of particular examples)
- observe and interpret life cycles of major plant and animal groups (through a study of particular examples)

2. ELECTROMAGNETIC SYSTEMS

Properties of electricity
- observe and describe electromagnetic effects of a current flowing through a wire

Measuring electrical energy
- construct and use a simple galvanometer (using a compass and wire)
- measure electrical potential of an electrical power source by use of a galvanometer or multimeter
- compare electrical consumption of various household devices

Producing electrical energy
- construct a device that produces electricity from chemical sources; also, through experimentation, improve the performance of the device
- construct a device that produces electricity by the movement of a magnet through a coil; also, through experimentation, improve the performance of the device
- construct a thermocouple experiment to improve the effectiveness of the thermocouple

Producing mechanical effects from electricity
- construct a device in which a coil (or magnet) is moved by electromagnetic force
- construct a model electric motor; improve the performance of the motor by troubleshooting and by minor modification of the design

Electrical resistance
- use a length of nichrome wire in as a variable resistor
- construct a device in which heat is produced electrically

Basic circuitry
- interpret simple circuit diagrams and prepare circuit diagrams for circuits constructed
- construct series and parallel circuits; predict the current flow in different parts of circuits constructed

Control circuitry and constructions
- construct a device in which a function is performed in response to a given condition; e.g., a model burglar alarm, an automatic door opener, a thermostatically controlled switch
- construct a device that shuts off automatically when a function is completed; e.g., a simple hoist which stops when a weight reaches a given height
- construct a device that performs two functions or operations; the second function is initiated when the first is complete; e.g., a hoist which automatically stops at a given height and switches on a light to signal that the function is complete

3. HEAT ENERGY: TRANSFER AND CONSERVATION

Heat and temperature

- observe temperature change toward an equilibrium temperature (e.g., trend toward room temperature of a container of hot or cold water); represent these observations graphically
- observe changes in temperatures in different materials as heat is added; compare differences in specific heat of materials (qualitative/comparative approach)
- observe and graph the temperature change as an ice water mixture is heated to boiling point

Conduction, convection and radiation

- observe different temperatures that occur at different locations within a body of water (or air) as it is heated
- observe effects of conduction, convection and radiation; infer the extent to which each of these mechanisms contributes to heat losses in given situations
- construct a model device that collects solar heat and transfers and/or stores that heat

Heat flow

- identify primary points of heat loss from a structure or from a thermal container
- by experimentation, compare the radiation of heat from black bodies and from white bodies, also absorption of heat
- by experimentation, compare conduction of heat in different materials

Insulation

- test the effectiveness of different materials as insulating materials
- construct insulated containers and test the effectiveness of those containers

4. FLUIDS AND PRESSURE

The nature of fluids
- compare the compressibility of a liquid and a gas; e.g., through the use of graduated plastic syringes
- by experimentation, compare the resistance to flow of a gas and a liquid
- by experimentation, compare the resistance to flow of different liquids
- by experimentation, compare the rate of flow of a liquid at different temperatures

Buoyancy
- compare the apparent weight of an object in air, and the apparent weight when submerged in water

Density
- construct, calibrate and use a simple hydrometer to measure the density of a fluid
- observe and compare the density of a solution as a solute is added; e.g., salt water solutions

Pressure
- construct and use a manometer to measure pressure in liquids; measure and interpret pressure change in response to depth
- measure pressure within a fluid system
- construct an improvised aneroid barometer; observe changes in response to changing pressure

Fluid systems
- construct a model in which a fluid can be used to transfer mechanical energy; e.g., plastic syringes linked by plastic tubing
- "invent" and use a one-way valve (based on a flapper valve principle or a marble in an opening)
- use valves in a fluid system; e.g., use of aquarium airhose valves, pinch clamps and/or student constructed valves
- compare the use of air and liquid in a fluid pressure system

Pumping systems
- observe and infer the operating principles of a simple pumping system (such as a bicycle pump or air mattress inflator)

Aerodynamic and hydrodynamic design
- observe turbulence and eddies in a current flow
- compare the drop rate of objects of the same mass but different shape
- construct a device that must move through a fluid (air/water) a maximum distance using a given input of energy; improve the efficiency of this device through modifications and improvements to the design

5. CHEMICAL PROPERTIES AND CHANGES

(Note that safety is a prime consideration in the selection of particular activities throughout this unit.)

Properties of materials
- observe, measure and compare solubility of given materials
- examine materials to observe and compare crystalline structures
- measure and compare melting points of materials
- measure and compare density of materials
- observe and experiment with materials provided, to determine some chemical and physical properties of those materials

Acids and bases
- use various indicators to measure pH
- observe and measure the acidity/alkalinity of various foods and materials found in the home
- observe and infer the reaction of acids and bases

Common household substances as chemicals
- identify general chemical properties of some common household substances and classify those substances according to composition
- classify household chemicals according to their hazardous properties and conditions for storage

Physical and chemical changes
- design and perform a simple identification test of materials (based on study of several materials that have a similar appearance)
- design and perform an identification test of mixtures of two or more materials (using materials studied previously)
- observe and infer the general nature of different kinds of chemical reactions
- classify reactions as chemical and physical
- observe and measure the heat generated by particular chemical reactions

Reaction rates
- observe and infer the effect of surface area particle size on reaction rate
- observe and infer the effect of temperature on the reaction rate of a given chemical reaction

Corrosion
- identify chemical weathering and the effects of corrosion on materials studied
- test and evaluate alternative methods for preventing or inhibiting corrosion

6. ENVIRONMENTAL QUALITY: A CASE STUDY

Environmental factors

- observe and measure abiotic factors that are basic to an environment; e.g., temperature, moisture, pH, light
- observe, identify and measure factors that are modified as the result of human activity; e.g., temperature, pH, moisture, light

Pollutants

- observe, identify, and measure materials added to environments as a result of human activity; i.e., solid wastes, liquid wastes and gaseous wastes. Activities may include:
  - observe and measure particles carried in air
  - observe and measure solid particles carried in water
  - monitor, analyze and classify solid wastes generated in the home

Effects of pollutants on living things

- through experimentation, determine the effect of adding small quantities of fertilizers and various wastes to pond water cultures

Knowledge of measurement technologies used in monitoring and measuring environmental quality (focus on one particular environment)

- apply the use of appropriate equipment and techniques in an extended study of a particular environmental quality indicator
- identify uncertainties in the collection and interpretation of environmental quality data

Environmental decision making

- analyze environmental quality of sample urban and natural environments; identify factors which would affect quality of life
- identify possible alternatives in responding to a particular environmental quality problem (may be based on an actual or hypothetical case study)
- identify implications of each alternative
- identify perspectives and points of view of different groups within the affected community
- identify impacts on other living things
- identify limits and uncertainties in the application of scientific knowledge to the solution of an environmental quality problem
- role play, debate or write an article on an environmental quality issue